

larger than our own, the fact of the existence of nearly 4,000 agricultural students is somewhat startling. In this country we have one agricultural college supported by less than 100 students. Yet we are the possessors of the most extensive colonies in the world, far exceeding, in extent, even the vast area of the United States. It may well be difficult for English agriculturists to compete with foreign rivals if the meagre number of agricultural students in England compared with America may be taken as in any degree a gauge by which interest in scientific progress may be measured.

CUMMING'S THEORY OF ELECTRICITY

An Introduction to the Theory of Electricity. By Linnaeus Cumming, M.A. (London: Macmillan and Co., 1876.)

MR. CUMMING deserves our thanks for having made an effort to introduce into elementary teaching the advances in the treatment of electricity made chiefly by the labours of Green, Thomson, and Clerk-Maxwell. Mr. Cumming possesses all the qualifications necessary for such a task. He evidently has a full knowledge of the subject, and seems to possess, in addition, experience as a teacher. He has had, no doubt, great difficulties to encounter. These difficulties are not alone due to the limitations as to the mathematical knowledge of his readers, which Mr. Cumming has justly imposed on himself. The books and papers out of which Mr. Cumming had to take his material, were written from various points of view, and they were chiefly addressed by scientific men to scientific men. It was natural that the same words should not be always used exactly in the same sense, the great object being that men already possessing a knowledge of the subject should understand each other. It is only when the knowledge of a certain subject is comparatively advanced that the terms settle down into a definite meaning. A text book, on the other hand, is addressed to students who at the most have only a slight acquaintance with the subject, and it should not only teach that particular subject, but also scientific method, and scientific reasoning. It is, therefore, of primary importance that the precise meaning of the term should be scrupulously adhered to. Even a good definition does not always ensure this, for there is often a metaphysical colouring which does not come out in the definition, but which we soon discover in the way a term is used. We take one example. The word potential is defined by Sir Wm. Thomson thus:—

"The potential at a point is the work which would be done on a unit of positive electricity by the electric forces if it were placed at that point without disturbing the electric distribution, and carried from that point to an infinite distance."

Nothing could be more precise than this, yet the word potential will call forth different associations in different minds, and this will greatly influence the way in which the word is used. Some writers will attach no meaning to the potential at a point, except in so far as they can imagine an electrified particle to be placed at that point, to others the expression will convey a perfectly definite meaning, defining the state of the medium at that point,

irrespective of any electrified particle which might be placed there. It will generally be soon found out in what sense the writer uses the word.

The passage in Mr. Cumming's book which has suggested these remarks, is contained in Prop. 8, p. 203. The proposition runs thus:—

"In computing the potential of any closed circuit, we may substitute for it any closed circuit which is obtained by projecting the given circuit by means of lines of force."

The expression potential of a circuit may perhaps have sometimes been used for the induction or number of lines of force through a circuit; yet we imagine the term suggests rather the idea of action at a distance, and would be analogous to substituting in electro statics the expression "potential of a point" for that generally used—"potential at a point." Mr. Cumming has so consistently adopted the views and language of Faraday and Clerk-Maxwell, that we have been struck rather unpleasantly by the passage. This is, perhaps, only a matter of detail, and we may here remark that Mr. Cumming might with advantage have bestowed more care on the wording of his propositions. On p. 40, for instance, an experimental law is given, and two exceptions are added. With very little trouble the law might have been worded so as to admit of no exceptions. Other examples might be given.

There is one feature in the book about which we should like to make a few remarks. An occasional allusion to hypothetical matters cannot of course be altogether avoided, yet we think that in books like Mr. Cumming's, which are intended to give an outline of what is known, and not of what is unknown, of the subject, such allusions should be reduced to a minimum.

On p. 119 five propositions are given on molecules and atoms, which are not alluded to throughout the book except in the following passage:—

"From the last statement it can be easily seen that when the molecules of two different solids impinge on each other, as at the surface of contact, they cannot accommodate themselves to each other's motion, but constrain each other, this constraint producing a loss of energy. If, however, the two solids are of the same kind and at the same temperature, the molecules on each side of the surface of contact are swinging in exactly the same manner, and can easily accommodate themselves to each other's motion without more constraint than exists in the solid part of either body. It is this loss of energy owing to the unsymmetrical swinging of the molecules at the surface of contact which reappears as difference of potential between the two solids, or as the energy of electrical separation."

"The opposed electricities so separated will, for the most part, be heaped up on either side of the plane of separation by a Leyden jar action."

In the same chapter Mr. Cumming gives his opinion on the theory of the voltaic cell and electrolysis in general. We are told how we might imagine the atoms and molecules to be placed; we are told about polarisation; but Faraday's laws are not even alluded to.

It would, of course, be an advantage to science if Mr. Cumming were to take an active part in the theoretical and experimental investigation of the subject; yet we doubt whether a text-book on the theory of electricity is the best place to bring his views forward, especially if

they are in contradiction to the best experiments we have on the subject (Sir William Thomson's). A teacher ought to be spared as much as possible from having to tell his students that he does not agree with the writer of a text-book.

The parts of Mr. Cumming's book which we have ventured to criticise refer chiefly to matters of taste. There is no doubt that in the hands of a good teacher the book will prove very useful. We hope that it will have a wide circulation, and that a second edition will soon enable Mr. Cumming to introduce such improvements as on a reperusal of his own book may occur to him.

ARTHUR SCHUSTER

OUR BOOK SHELF

Proceedings of the London Mathematical Society, vol. vii. November, 1875, to November, 1876. (London: Messrs. Hodgson and Son, Gough Square.)

IN the present volume we have about thirty communications made by eighteen writers. Prof. Cayley writes on Three-bar Motion (treating the matter in a different way from that in which it is handled in this same volume by Mr. S. Roberts, the priority of whose results is conceded by Mr. Cayley) on the Bicursal Sextic; Prof. H. J. S. Smith contributes short papers on the value of a certain Arithmetical Determinant and a Note on the Theory of the Pellian Equation; Lord Rayleigh has a note on the Approximate Solution of certain Potential Problems; Mr. Spottiswoode writes on Determinants of Alternate Numbers, working out some suggestions of Prof. Clifford. This last-named gentleman contributes the transformation of Elliptic Functions with a Note, and Free Motion under no Forces of a Rigid System in an n -fold Homaloid.

In Analysis, there are further papers by Mr. J. W. L. Glaisher on an Elliptic Function Identity, and the Summation of the Geometrical Series of the n th Order as a Definite Integral; Prof. Lloyd Tanner on the Solution of Certain Partial Differential Equations of the Second Order (two papers); Mr. J. Hammond on the Relation between Bernoulli's Numbers and the Binomial Coefficients, and on the Mean of the Products of the Different Terms of a Series; Mr. T. Muir on the Transformation of Gauss's Hypergeometric Series into a Continued Fraction; Mr. S. Roberts a Further Note on the Motion of a Plane under Certain Conditions; Mr. Hewitt on a Theorem of Eisenstein's.

Under the heading of Geometry we may class Prof. Rudolf Sturm's paper on Correlative Pencils; Mr. A. B. Kempe's General Method of describing Plane Curves of the n th Degree by Linkwork; Prof. Wolstenholme's Loci Connected with the Rectangular Hyperbola.

There are a few shorter communications. We have said enough to give our mathematical readers an idea of the range of subjects treated in this volume. The names of the authors are a sufficient guarantee that the subjects are ably treated and brought down to the latest accepted results.

A Primer of Chemistry, including Analysis. By Arthur Vacher. (London: J. and A. Churchill, 1877.)

THIS little book attempts to present within the limits of a hundred pages "a general view of the elements of inorganic chemistry." It embodies the experience gained by the author during ten years in which he has been engaged in teaching the subject, and the result is that many points are treated in somewhat novel fashion. The subject is considered as fully as could be expected within the narrow limits mentioned, and the amount of information conveyed is really considerable and generally accurate.

The first sixty-seven pages contain chapters on "Ex-

periments with some of the Elements," "The Use of Symbols" in formulae, equations, and calculations, "Experiments with some Compounds," "Weights and Measures," "Classification of Compounds," and "List of Substances." The remaining thirty pages or so are devoted to Qualitative Analysis.

Perhaps the greatest novelty introduced is the use of the term *unit* instead of atomic or combining weight, so as to avoid using the terms *atom* and *molecule*, which the author thinks are "unsuitable for ordinary use among beginners;" and of *antimetal* instead of *radicle* (which latter by the way he incorrectly writes "radical"). It may be questioned whether the use of the term "unit" may not interfere with the conception of the meanings to be attached to "atom" and "molecule," which the pupil must gain afterwards. "Antimetal" is objectionable since all radicles are not antimetals; ammonium, for example, is a radicle which plays the part of a metal. Clearly the term is intended as equivalent to "acid radicle," or acid minus its basic hydrogen; it is never used in any other sense in the book, and its use with this restricted meaning may be advantageous, or at least free from objection.

Several items may be pointed out as requiring alteration or improvement; notably the following: that "a compound" is any substance which is not an element" (p. 11); that chlorine has a "pale green colour" (pp. 6 and 61); that oxygen is *insoluble* in water (pp. 39 and 56); and that KMnO_4 gives a *red* solution (p. 64). In working with test-tubes the student is several times directed to add "half an inch" of acid or water as the case may be. Of course it is evident what is meant, but test-tubes are of various sizes, and a large excess of acid or other liquid would be used if the directions were followed exactly with large tubes. On p. 77, "take the charcoal quickly to your nose" is another rather curious direction.

The analytical part of the book is the best; the tables throughout being reliable. The detection and separation of cobalt and nickel (Table III., p. 95) might be effected more quickly and easily by other methods than that given; and on p. 87, NO_3 as well as CrO_4 and Fe''' should be mentioned as decomposing H_2S . If these and several other minor improvements be made the "primer" will not be without value in imparting the rudiments of education in chemistry; and in these days when elementary text-books are becoming so numerous, may fairly count on being appreciated as it deserves by the class of students for whom it is intended.

W. H. W.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

Hibernation of Birds

IN NATURE (vol. xv., p. 465) there is a review of "Palmén on the Migration of Birds," and in the course of it the reviewer takes occasion to refer to what he calls the "hibernation mania" as one that is now and again revived, in spite of the fact that the migration of birds is fully proved, and that no evidence at first hand has ever been produced in favour of the supposition that birds ever lie dormant.

Having frequently heard my brother-in-law, Sir John McNeill, relate a circumstance which occurred to himself proving that swallows do occasionally lie dormant, I wrote to him asking him for the particulars. I now inclose his reply, which perhaps you will publish, as it may possibly elicit other evidence on the same matter.

Gilbert White's conviction that swallows do occasionally lie dormant in this country, was mainly founded on the fact that instances are not uncommon of swallows appearing suddenly

¹ A chemical compound being meant as is evident from the context.